Practitioner's Docket No. 55618

CHAPTER II

TRANSMITTAL LETTER TO THE UNITED STATES ELECTED OFFICE (EO/US) (ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

PCT/DE99/02938	15 September 1999	30 September 1998
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED

CIRCUIT FOR TRANSFORMING AN IMAGE RATE
TITLE OF INVENTION

Günter SCHEFFLER and Markus SCHU
APPLICANTS

Box PCT
Assistant Commissioner for Patents
Washington D.C. 20231
ATTENTION: EO/US

NOTE: To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

WARNING: *Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. §1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing - See 37 C.F.R. §1.8.*

NOTE: Documents and fees must be clearly identified as a submission to enter the national state under 35 USC 371 otherwise the submission will be considered as being made under 35 USC 111. 37 C.F.R. § 1.494(f).

CERTIFICATION UNDER 37 C.F.R. § 1.10*
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I hereby certify that this paper, along with any document referred to, is being deposited with the United States Postal Service on this date March 30, 2001, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number **EL835032473US**, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

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1. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. 371:

   a. [X] This express request to immediately begin national examination procedures (35 U.S.C. 371(f)).

   b. [X] The U.S. National Fee (35 U.S.C. 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2. Fees

CLAIMS FEE [X]*	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS
	TOTAL CLAIMS	- 20 =	0	x $ 18.00 =	$0
	INDEPENDENT CLAIMS	- 3 =	0	x $ 80.00 =	$0
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + $270.00				$
BASIC FEE**	[ ] U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: [ ] and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(2) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 CFR 1.492(a)(4)) ..... $96.00 [ ] and the above requirements are not met (37 CFR 1.492(a)(1)) ..... $670.00 [X] U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the USPTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: [ ] has been paid (37 CFR 1.492(a)(2)) ..... $760.00 [ ] has not been paid (37 CFR 1.492(a)(3)) ..... $970.00 [X] where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 CFR 1.492(a)(5)) $860.00				$860.00
				Total of above Calculations	= $860.00
SMALL ENTITY	Reduction by ½ for filing by small entity, if applicable. Affidavit must be filed. (note 37 CFR 1.9, 1.27, 1.28)				- $
				Subtotal	$860.00
				Total National Fee	$860.00
	Fee for recording the enclosed assignment document $40.00 (37 CFR 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".				$
TOTAL				Total Fees enclosed	$860.00

*See attached Preliminary Amendment Reducing the Number of Claims.

   i. [X] A check in the amount of $860.00 to cover the above fees is enclosed

   ii. [ ] Please charge Account No. _____ in the amount of $ _____.

A duplicate copy of this sheet is enclosed.

**WARNING: *"To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: * * * (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).*

WARNING: *If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.*

3. [X] A copy of the International application as filed (35 U.S.C. 371(c)(2)):

NOTE: *Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.*

a. [ ] is transmitted herewith.
b. [ ] is not required, as the application was filed with the United States Receiving Office.
c. [X] has been transmitted
   i. [X] by the International Bureau.
   Date of mailing of the application (from form PCT/IB/308): _____.
   ii. [ ] by applicant on _____.
   Date

4. [X] A translation of the International application into the English language (35 U.S.C. 371(c)(2)):
a. [X] is transmitted herewith.
b. [ ] is not required as the application was filed in English.
c. [ ] was previously transmitted by applicant on _____.
   Date
d. [ ] will follow.

5. [X] Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. 371(c)(3)):

NOTE: *The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36*

a. [ ] are transmitted herewith.
b. [ ] have been transmitted

i. [ ] by the International Bureau.
Date of mailing of the amendment (from form PCT/IB/308): _____.

ii. [ ] by applicant on _____.
Date

c. [X] have not been transmitted as

i. [X] applicant chose not to make amendments under PCT Article 19.
Date of mailing of Search Report (from form PCT/ISA/210): **16/03/00**

ii. [ ] the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. [X] A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. 371(c)(3)):

a. [ ] is transmitted herewith.
b. [ ] is not required as the amendments were made in the English language.
c. [X] has not been transmitted for reasons indicated at point 5(c) above.

7. [X] A copy of the international examination report (PCT/IPEA/409)

[X] is transmitted herewith.
[ ] is not required as the application was filed with the United States Receiving Office.

8. [ ] Annex(es) to the international preliminary examination report

a. [ ] is/are transmitted herewith.
b. [ ] is/are not required as the application was filed with the United States Receiving Office.

9. [ ] A translation of the annexes to the international preliminary examination report

a. [ ] is transmitted herewith.
b. [ ] is not required as the annexes are in the English language.

10. [X] An oath or declaration of the inventor (35 U.S.C. 371(c)(4)) complying with 35 U.S.C. 115

a. [ ] was previously submitted by applicant on _____.
Date

b. [ ] is submitted herewith, and such oath or declaration

i. [ ] is attached to the application.
ii. [ ] identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. 1.70.
iii. [X] will follow.

II. Other document(s) or information included:

11. [X] An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):

a. [X] is transmitted herewith.
b. [ ] has been transmitted by the International Bureau.
Date of mailing (from form PCT/IB/308): _____.

c. [ ] is not required, as the application was searched by the United States International Searching Authority.
d. [ ] will be transmitted promptly upon request.
e. [ ] has been submitted by applicant on _____. Date

12. [X] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98:
a. [X] is transmitted herewith.
Also transmitted herewith is/are:
[X] Form PTO-1449 (PTO/SB/08A and 08B).
[X] Copies of citations listed.
b. [ ] will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. 371(c).
c. [ ] was previously submitted by applicant on _____. Date

13. [ ] An assignment document is transmitted herewith for recording.

A separate [ ] "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or [ ] FORM PTO 1595 is also attached.

14. [X] Additional documents:
a. [X] Copy of request (PCT/RO/101)
b. [X] International Publication No. WO 00/19713
i. [X] Specification, claims and drawing
ii. [ ] Front page only
c. [ ] Preliminary amendment (37 C.F.R. § 1.121)
d. [X] Other

Preliminary Amendment, Forms PCT/IB/304, PCT/IB/306, PCT/ISA/210, PCT/IPEA/409.

15. [X] The above checked items are being transmitted
a. [X] before 30 months from any claimed priority date.
b. [ ] after 30 months.

16. [ ] Certain requirements under 35 U.S.C. 371 were previously submitted by the applicant on _____, namely:

AUTHORIZATION TO CHARGE ADDITIONAL FEES

WARNING: *Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges if extra claims are authorized.*

NOTE: "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

NOTE: "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

[X] The Commissioner is hereby authorized to charge the following additional fees that may be required by this paper and during the entire pendency of this application to Account No. **04-1105**.

[X] 37 C.F.R. 1.492(a)(1), (2), (3), and (4) (filing fees)

WARNING: *Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.*

[X] 37 C.F.R. 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action

[X] 37 C.F.R. 1.17 (application processing fees)
[X] 37 C.F.R. 1.17(a)(1)-(5)(extension fees pursuant to § 1.136(a).
[ ] 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

NOTE: 37 C.F.R. 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

[ ] 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

SIGNATURE OF PRACTITIONER

Reg. No.: 33,860

Peter F. Corless
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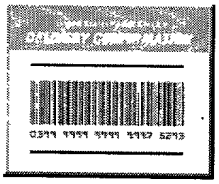

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Wednesday, September 05, 2001 05:29 PM

Docket No. 55618

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: G. SCHEFFLER et al.

EXPRESS MAIL LABEL NO.: EL 835032467US

FILED: Herewith

FOR: CIRCUIT FOR TRANSFORMING RATE

THE HONORABLE COMMISSIONER OF PATENTS AND TRADEMARKS
WASHINGTON, DC 20231

SIR:

PRELIMINARY AMENDMENT

Applicants file herewith the above-identified application. Please amend the application as follows.

IN THE CLAIMS

Please cancel claims 1-7 without prejudice.

Please add the following new claims.

8. Circuit for frame rate (field repetition frequency) conversion in a video signal reproduction device using a motion-adaptive method, having a motion detector for producing motion values of pixels by means of which a device for switching a field sequence with the frame rate being doubled can be actuated,

wherein the motion detector comprises a first device for producing pixel motion signals, which have a first state for each pixel which is found to have moved and a second state for each pixel which is found to have been stationary, and a second device by means of which the pixel motion signals are corrected in order to produce motion values in such a manner that a state which differs from matching states of adjacent pixels is ignored.

9. Circuit according to Claim 8, wherein in order to determine the first or second state, the first device has units for producing controlled characteristics for assessment of field differences as a function of line differences, with the motion sensitivity being increased if the line difference are small, and the motion sensitivity being reduced if the line differences are large.

10. Circuit according to Claim 9 wherein the first device has circuit units for forming line and field differences, with the field difference being assessed by the units for producing line differences are applied and being mapped onto 1-bit signals, and these 1-bit signals being logically combined by an OR gate in order to produce the pixel motion signals.

11. Circuit according to claim 10 wherein the third, fourth and the fifth circuit unit are used to produce three field differences from a first, a second and a third field, and in that the units for producing controlled characteristics are controlled using the maximum of the line difference signals from the first and second field.

12. Circuit according to 8 wherein the second device comprises a correction unit for processing the motion signals of each pixel in such a manner that the first state is corrected to the second state if the motion signals of all the adjacent pixels are in the second state, with a previously corrected state being used for the processing of a subsequent pixel.

13. Circuit according to claim 8 wherein the second device comprises a correction unit for processing all the motion signals in a line in such a manner that the first state is changed to the second state if the motion signals in one and two lines above and in one line underneath are in the second state.

14. Circuit according to claim 13 wherein the second device comprises further correction units by means of which moving picture areas are homogenized by insertion of motion signals which are in the first state.

REMARKS

Claims 1-7 have been cancelled without prejudice, and claims 8-14 have been added. No new matter has been added by virtue of the amendments. Support for the new claims appears e.g. in the original claims. The claims have been added to better comply with U.S. style.

Early consideration and allowance of the application are earnestly solicited.

Respectfully submitted,

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GR 98 P 2861

Description

Circuit for frame rate conversion

The invention relates to a circuit for frame rate (field repetition frequency) conversion in a video signal reproduction device using a motion-adaptive method, having a motion detector for producing motion values of pixels by means of which a device for switching the field sequence with the frame rate being doubled can be actuated.

Circuits of this type are generally used for doubling the field repetition frequency of 50 or 60 Hz in television sets in order in this way to reduce the large-area flickering and to produce a picture which is smoother overall.

For frame rate conversion, a distinction is drawn between static methods on the one hand and motion-adaptive and/or motion-compensating methods on the other hand.

In a static method, the two fields A and B are duplicated and, as shown in Figure 7, are reproduced either successively (AABB, Figure 7a) or interleaved (ABAB, Figure 7b). AABB reproduction has the disadvantage that, although very good motion representation is feasible, edge flickering cannot be reduced in this way, however. In comparison to this, it is possible using the ABAB raster sequence, which in practice means duplication of the frame, to reduce edge flickering in stationary pictures. However, this type of reproduction will not cope with moving pictures.

Furthermore, static methods as shown in Figure 8 are known which operate with an AA*B*B raster sequence, with the A* and B* fields being calculated using linear or nonlinear methods. For example, the use of median

filters is known for this purpose, using which the fields $(A^*)^n$ and $(B^*)^n$ are produced by interpolation of the fields A^n and B^n, and B^n and A^{n+1}, respectively.

Motion-adaptive and motion-compensating methods differ from static methods by using a motion detector and/or a motion estimator block. The appropriate field interleaving is illustrated in principle in Figure 9. The motion detector block produces only information about the presence of motion in the picture, while the motion estimator block also determines information about the magnitude and direction of the motion. This information can be used in various ways to improve the frame rate conversion. For example, it is possible to switch between the two static methods mentioned above on a pixel or frame basis, depending on this information.

However, a disadvantage of all these methods is the fact that they are highly complex, particularly if motion-dependent switching between the various raster or field sequences and interpolation are intended to be carried out.

The invention is therefore based on the object of providing a circuit of the type mentioned initially using which considerably better picture quality, particularly for moving pictures, can be achieved in a relatively simple manner.

According to Claim 1, this object is achieved by a circuit of the type mentioned initially in which the motion detector comprises a first device for producing pixel motion signals, which have a first state for each pixel which is found to have moved and a second state for each pixel which is found to have been stationary, and has a second device by means of which the pixel motion signals are corrected in order to produce motion

values in such a manner that a state which differs from matching states of adjacent pixels is ignored.

Particular advantages of this solution are that there is no need for any feedback of the motion values calculated for a previous frame. Furthermore, there is no need for the multiplier which is generally required for the combination of methods with different field sequences, since a simple changeover switch can be actuated by the motion values produced according to the invention. Furthermore, the correction of the pixel motion signals according to the invention results in the production of motion values using which even rapid motion of small objects can be detected and taken into account.

The contents of the dependent claims cover advantageous developments of the invention.

According to these dependent claims, in order to determine the first or second state, the first device preferably has units for producing controlled characteristics for assessment of field differences as a function of line differences, with the motion sensitivity being increased if the line differences are small, and the motion sensitivity being reduced if the line differences are large.

Furthermore, the first device preferably has circuit units for forming line and field differences, with the field differences being assessed by the units for producing controlled characteristics to each of which the line differences are applied and being mapped onto 1-bit signals, and these 1-bit signals being logically combined by means of an OR gate in order to produce the pixel motion signals.

The production of a 1-bit control signal makes it possible to switch in a simple manner between two different field sequences for each pixel.

Furthermore, the second device preferably comprises a first circuit unit for processing the motion signals of each pixel in such a manner that the first state is changed to the second state if the motion signals of all the adjacent pixels are in the second state, with a previously corrected state being used for the processing of a subsequent pixel.

This results in two-dimensional correction of the pixel motion signals using plausibility criteria, and homogenization of picture areas by erasing and filling motion values, and this leads to a further improvement in the picture quality.

Further details, features and advantages of the invention result from the following description of a preferred embodiment with reference to the drawing, in which:

Figure 1 shows a block diagram of a circuit according to the invention;

Figure 2 shows a block diagram of a first device in the circuit according to the invention;

Figure 3 shows a block diagram of components of the first device;

Figure 4 shows a block diagram of further components of the first device;

Figure 5 shows a block diagram of a second device in the circuit according to the invention;

Figures 6a to 6g show pixel corrections to illustrate the production of motion values according to the invention;

Figures 7a, b show various known raster sequences, using which fields are displayed by means of a static method in order to double the frame rate;

Figure 8 shows production and display of interpolated fields using a static method; and

Figure 9 shows production and display of fields using a motion-adaptive and/or motion-compensating method.

The invention is based on the knowledge that particularly good picture quality can be achieved if a motion detector provides pixel information about the motion state of a pixel, and this information is used for switching between two different methods, which are each optimized for the motion state. This is particularly appropriate if the stationary picture parts are displayed using a raster sequence (field sequence) ABAB, and the moving picture parts are displayed using the raster sequence AA*B*B, as in the explanation in the introduction. Corresponding pixel-dependent switching allows the advantages of both reproduction types to be combined.

Figure 1 shows a block diagram of a circuit according to the invention. The circuit comprises a first field memory 1, a second field memory 2 connected in series with it, and a motion detector 3. The motion detector comprises a first device 31 for producing pixel motion signals, and a second device 32 for producing motion values from them.

The field signals which are applied to the input of the circuit are buffer-stored in the first and the second field memories 31, 32 and are supplied as a first, a second and a third field A, B, C, which follow one another, to the first device 31 in the motion detector 3.

The first device 31 is used to carry out filtering and to form various difference values which are calculated and combined with one another pixel-by-pixel. This results in pixel motion signals which, for each pixel indicate by a first state whether the corresponding pixel should be regarded as moving, and denote by a second state a pixel which should be classified as stationary.

The second device 32 is used to carry out subsequent processing of the states of the pixel motion signals. The aim of this subsequent processing is to homogenize the moving and stationary picture areas. For this purpose, individual small areas in which the pixel motion signals are in the first state and which lie within a relatively large area in which the pixel motion signals are in the second state are eliminated, or are likewise changed to the second state.

Conversely, individual pixels which have been assigned to the second state and which are located within an area with pixels in the first state are assigned to the first state. This results in homogeneous areas which are identified as being moving and correspond to moving picture parts.

This subsequent processing has the particular advantage that a downstream 100 Hz converter (changeover switch) operates in a stable manner in the sense that it does not switch continuously between the two raster methods explained initially with reference to Figures 7a and 7b, which would lead to very disturbing artifacts.

Figure 2 shows a corresponding block diagram of the first device 31. The first device 31 comprises a first circuit unit 311 to which the first field A is applied, and a second circuit unit 312 to which the second field B is supplied. The two circuit units 311, 312 are each used to form line differences. The unit 320 forms the maximum from the two time differences. Furthermore, a third, a fourth and a fifth circuit unit 313, 314 and 315 are provided, and these are each used to produce frame differences. The first and the second field A, B are applied to the third circuit unit 313. The fourth circuit unit 314 is supplied with the first and the third fields A, C, while the second and the third fields B, C are applied to the fifth circuit unit 315.

The outputs of the third, fourth and fifth circuit units are connected respectively to a first, a second and a third unit 316, 317, 318 in order to produce controlled characteristics. The outputs of these "characteristic controllers" are logically combined using an OR gate 319. The output from the unit 320 is applied to all the characteristic controllers.

The characteristic controllers map the frame differences A-B, A-C and B-C which are produced onto 1-bit signals in order to produce the pixel motion signals. This is done by assessing the frame differences as a function of the line differences from the fields A and B. In this case, the sensitivity is increased if the line differences are small, and the sensitivity is reduced if the line differences are large. The characteristics may expediently be in the form of look-up tables. The maximum of the time differences between the fields A and B controls all the frame differences.

Evaluation of the three different frame differences has therefore been found to be highly advantageous since

this allows even small objects which are moving very fast to be detected.

The first and second circuit units 311 and 312, respectively, for forming line differences are shown in detail in Figure 3. Each of these two circuit units comprises in each case one first line memory 3110 which is connected to the input and to whose output a second line memory 3111 is connected. Furthermore, a first subtractor 3112 is provided, which is connected to the input of the circuit unit and to the output of the first line memory 3110. A second subtractor 3113 is connected to the output of the first line memory 3110 and to the output of the second line memory 3111. The output of the first subtractor 3112 is connected to a first unit 3114 for magnitude formation, while the output of the second subtractor 3113 is connected to a second unit 3115 for magnitude formation. The outputs of the first and second units for magnitude formation are jointly connected to a unit 3116 for maximum-value determination, whose output signal is supplied via a first attenuator 3117 and a first low-pass filter 3118 following it, to the characteristic controller 316, to which threshold values are applied.

Figure 4 shows, in detail, the construction of the circuit units 313, 314, 315 for producing frame differences. These have a first and a second vertical filter 3130, 3131, whose outputs are connected to a third subtractor 3132. The output of the third subtractor 3132 is connected to the input of a second low-pass filter 3133. Its output signal is supplied to a limiter 3136, via a third unit 3134 for magnitude formation and via a second attenuator 3135 following it.

Fields in a different raster position are in each case processed in the first and third circuit units 313, 315. This takes account of the fact that the vertical

filters 3130, 3131 shift the raster position so that, after this, the two fields are in the same raster position. In contrast, fields in the same raster position are processed in the second circuit unit 314. In this case, only low-pass filtering is carried out in the vertical direction. The raster position in this case remains unchanged.

The second device 32, using which the pixel motion signals for producing motion values are corrected or subsequently processed, is shown in detail in Figure 5 and will be explained with reference to Figures 6a to 6h. This subsequent processing is carried out in a number of steps.

A first correction unit 321 carries out first deletion (horizontal processing) of individual pixel motion signals which are in the first state (moving) in a surrounding area of pixel motion signals which are in the second state (stationary). Specifically, in this case, there is a high probability that this represents incorrect classification by the first device 31, since moving objects generally have a larger extent. In order to correct this state, a mask is placed over the entire picture and a decision is made for each pixel motion signal as to whether it will or will not be deleted. The mask is shown schematically in Figure 6a:

The present pixel motion signal A with the first state is deleted or changed to the second state if all the surrounding signals a, b and c indicate the second state. The corrected signal A becomes the point b on correction of the subsequent signal, that is after shifting the mask one pixel to the right. The corrected value at the point A is likewise used as a for correction of the signal which is located exactly under the signal A. This means that, once the values have been calculated, they are used recursively once again as input values for the subsequent corrections. This

means that the deletion algorithm operates very effectively.

A second correction unit 322 is used for deleting lines (vertical processing). In this case, a subsequent block in each case deletes individual horizontally running lines. The correction is once again carried out for each pixel. The mask which is used is shown in Figure 6b:

The pixel motion signal A of the present pixel is changed to the second state if the signals in one and two lines above and one line below are in the second state. Non-recursive processing is used in this case.

A third correction unit 323 then carries out initial insertion of pixel motion signals (horizontal processing), with the corresponding mask being shown in Figure 6c:

After the first two steps, there are still individual set pixel motions signals with an extent of two pixels in the horizontal direction. These will be deleted later by a fourth correction unit 324. However, within moving objects, there are also groups of two which, of course, must not be deleted. Since the corresponding pixels are located within relatively large moving objects, there are always a number of pixel motion signals in the first state in their immediate vicinity. The deletion process can therefore be prevented by filling the gaps between them with pixel motion signals in the first state. This is done by the third correction unit 323 by considering the horizontally adjacent pixel motion signals a, b, c and d. If one of the signals a or A is set, and one of the signals b, c, d is set at the same time as well, then the present pixel motion signal is changed to the first state. This algorithm operates recursively, that is to say the

result of the correction is used as point a for the next correction.

The fourth correction unit 324 carries out a second deletion of pixel motion signals (horizontal processing). This process is illustrated in Figure 6d. The present pixel motion signal A is assigned to the second state if none of the surrounding pixel signals a, b, c, d is in the first state. This algorithm also operates recursively.

A fifth correction unit 325 expands the pixel motion signals (horizontal processing). This is illustrated in Figure 6e. This step results in an area of pixel motion signals which are in the first state in each case being enlarged by one pixel at the right and left-hand edges in the horizontal direction. A simple OR logic operation on the three motion signals a, A and b can be used for this purpose. Processing in this case is not recursive.

Then, according to Figure 6f, a sixth correction unit 326 carries out line expansion (vertical processing) with the areas which are in the first state being enlarged by one line in the vertical direction.

A seventh and an eighth correction unit 327 and 328 now homogenize the moving areas by inserting pixel motion signals in the first state. The previous steps have resulted in undesired motion signals having been eliminated so that inhomogeneous moving picture areas can now be filled in in a broadbrush manner.

The seventh correction unit 327 carries out a second insertion process for pixel motion signals, and this is shown in Figure 6g. This step operates in the horizontal direction. If the already processed value a or the present value A is set and one of the values b, c, d, e, f, g or h is set at the same time, the present

value is assigned to the first state. Processing is carried out recursively.

Finally, the eighth correction unit 328 inserts lines (vertical processing). This is illustrated in Figure 6h. The present pixel motion signal A is assigned to the first state if two values are set in one of the first two lines and two values are at the same time set in one of the following four lines. Processing is carried out recursively in this case as well. The values a, b, c and d are thus already corrected values.

Overall, the pixel motion signals are consequently corrected such that motion values are produced which define homogeneous picture areas which are clearly delineated from one another and are defined either cohesively as being moving or as being stationary.

Patent Claims

1. Circuit for frame rate (field repetition frequency) conversion in a video signal reproduction device using a motion-adaptive method, having a motion detector for producing motion values of pixels by means of which a device for switching a field sequence with the frame rate being doubled can be actuated,
characterized in that
the motion detector (3) comprises a first device (31) for producing pixel motion signals, which have a first state for each pixel which is found to have moved and a second state for each pixel which is found to have been stationary, and has a second device (32) by means of which the pixel motion signals are corrected in order to produce motion values in such a manner that a state which differs from matching states of adjacent pixels is ignored.

2. Circuit according to Claim 1,
characterized in that,
in order to determine the first or second state, the first device (31) has units (316, 317, 318) for producing controlled characteristics for assessment of field differences as a function of line differences, with the motion sensitivity being increased if the line differences are small, and the motion sensitivity being reduced if the line differences are large.

3. Circuit according to Claim 2,
characterized in that
the first device (31) has circuit units (311, 312; 313, 314, 315) for forming line and field differences, with the field differences being assessed by the units (316, 317, 318) for producing controlled characteristics to each of which the line differences are applied and being mapped onto 1-bit signals, and these 1-bit signals being logically combined by means of an OR gate (319) in order to produce the pixel motion signals.

4. Circuit according to Claim 2 or 3,
characterized in that
the third, the fourth and the fifth circuit unit (313, 314, 315) are used to produce three field differences from a first, a second and a third field, and in that the units (316, 317, 318) for producing controlled characteristics are controlled using the maximum of the line difference signals from the first and the second field.

5. Circuit according to one of the preceding claims,
characterized in that
the second device (32) comprises a first correction unit (321) for processing the motion signals of each pixel in such a manner that the first state is corrected to the second state if the motion signals of all the adjacent pixels are in the second state, with a previously corrected state being used for the processing of a subsequent pixel.

6. Circuit according to one of the preceding claims,
characterized in that
the second device (32) comprises a second correction unit (322) for processing all the motion signals in a line in such a manner that the first state is changed to the second state if the motion signals in one and two lines above and in one line underneath are in the second state.

7. Circuit according to Claim 6,
characterized in that
the second device (32) comprises further correction units (327, 328) by means of which moving picture areas are homogenized by insertion of motion signals which are in the first state.

GR 98 P 2861

Abstract

Circuit for frame rate conversion

The circuit is distinguished in that the motion detector (3) comprises a first device (31) for producing pixel motion signals, which have a first state for each pixel which is found to have moved and a second state for each pixel which is found to have been stationary, and has a second device (32) by means of which the pixel motion signals are corrected in order to produce motion values in such a manner that a state which differs from matching states of adjacent pixels is ignored.

FIGURE 1

FIG 1

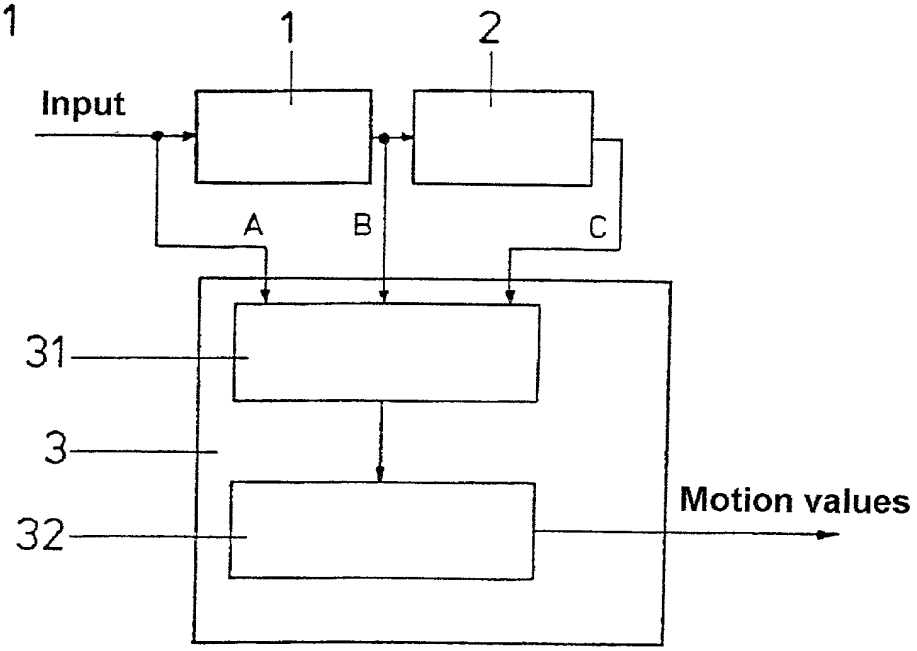


FIG 2

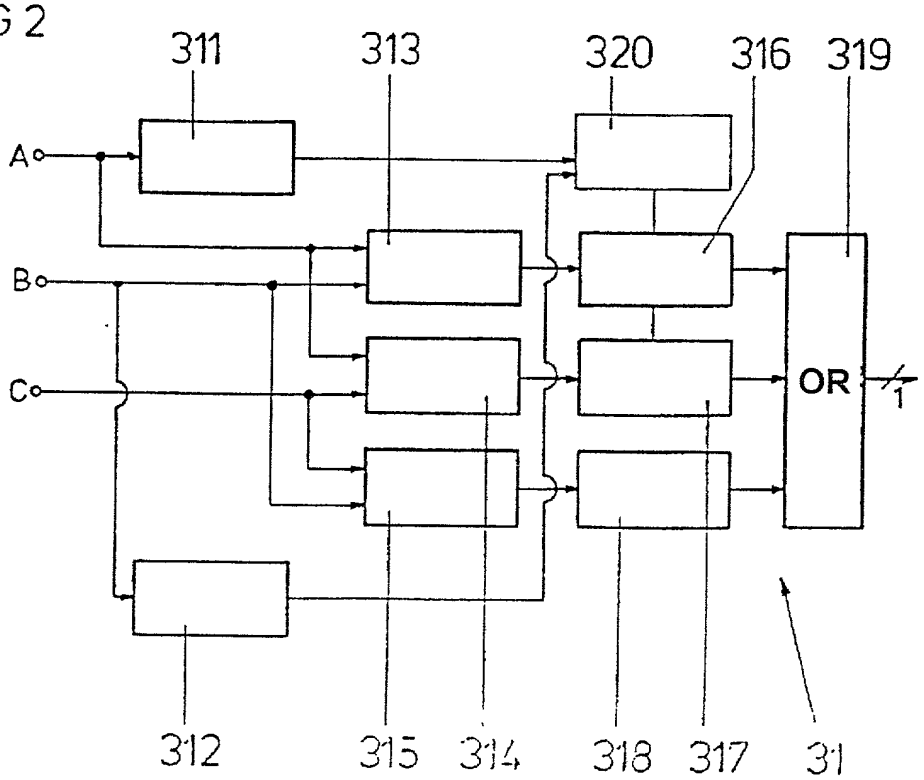


FIG 3

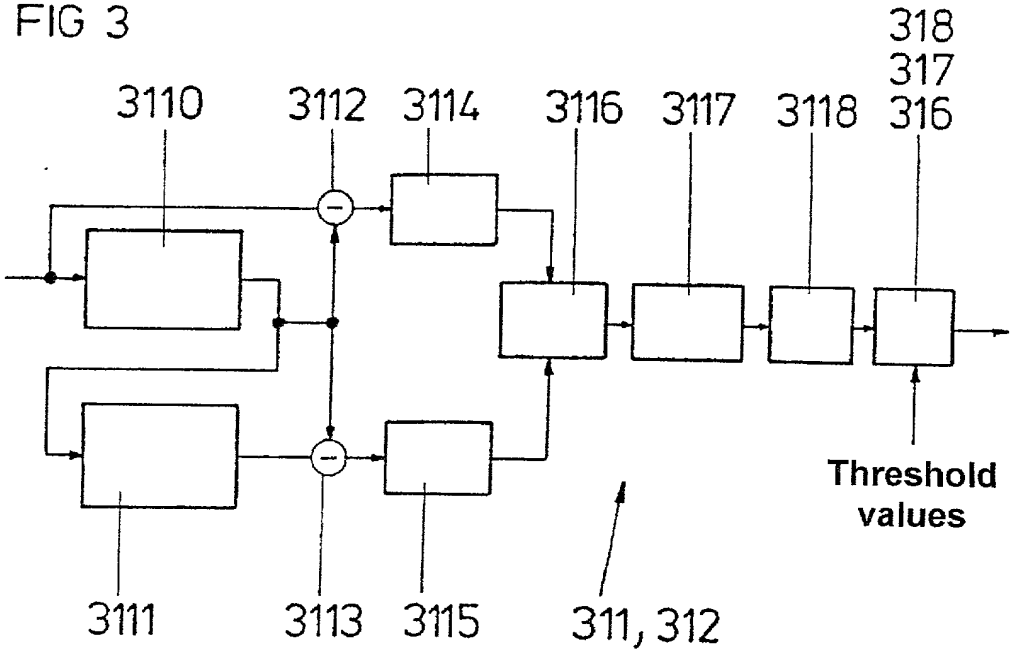


FIG 4

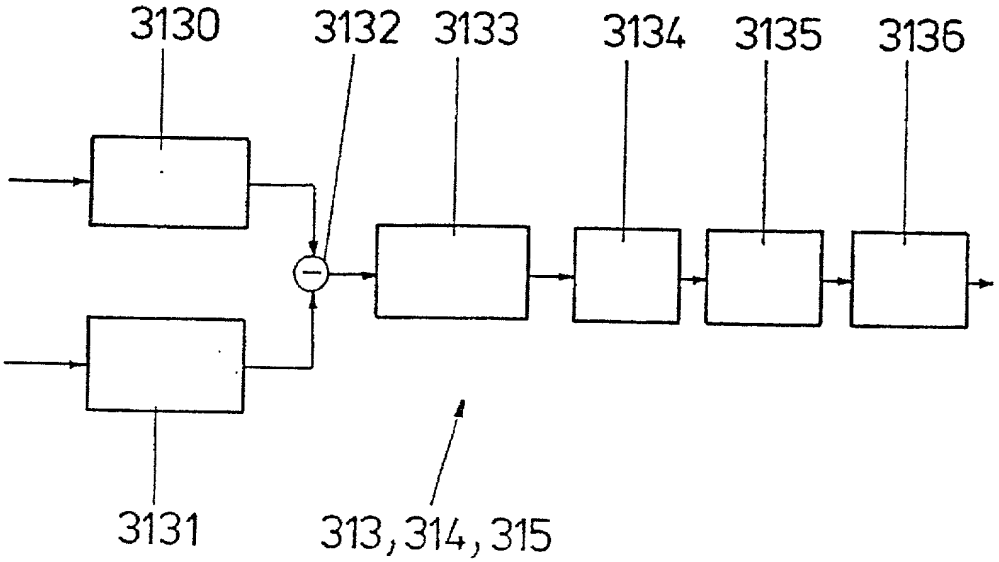


FIG 5

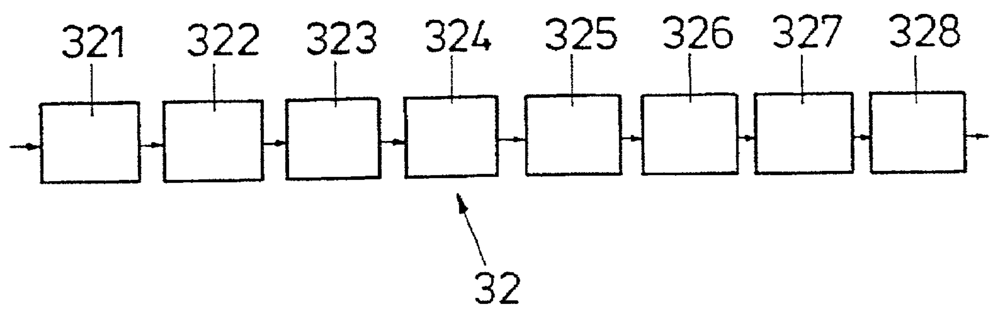


FIG 6a

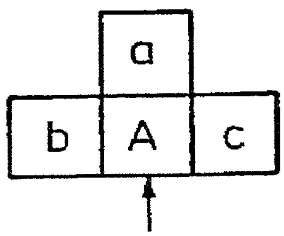


FIG 6b

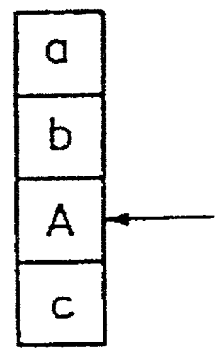


FIG 6c

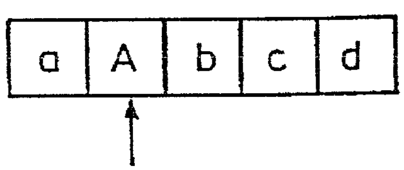


FIG 6d

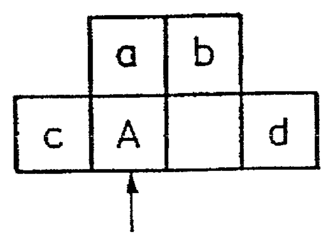


FIG 6e

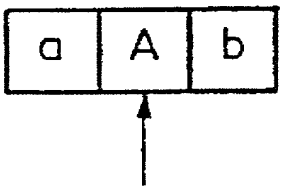


FIG 6f

FIG 6g

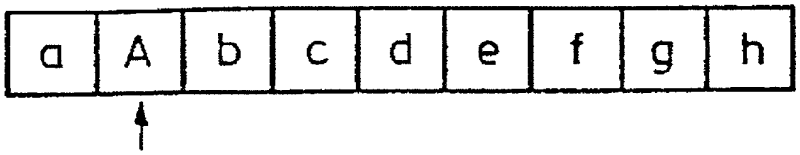


FIG 6h

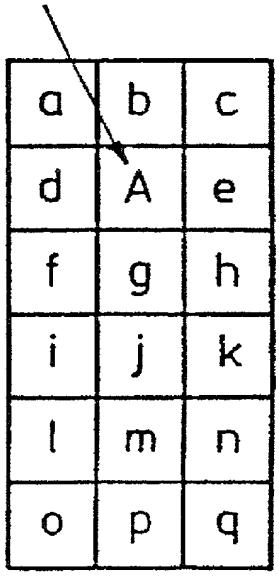


FIG 7a

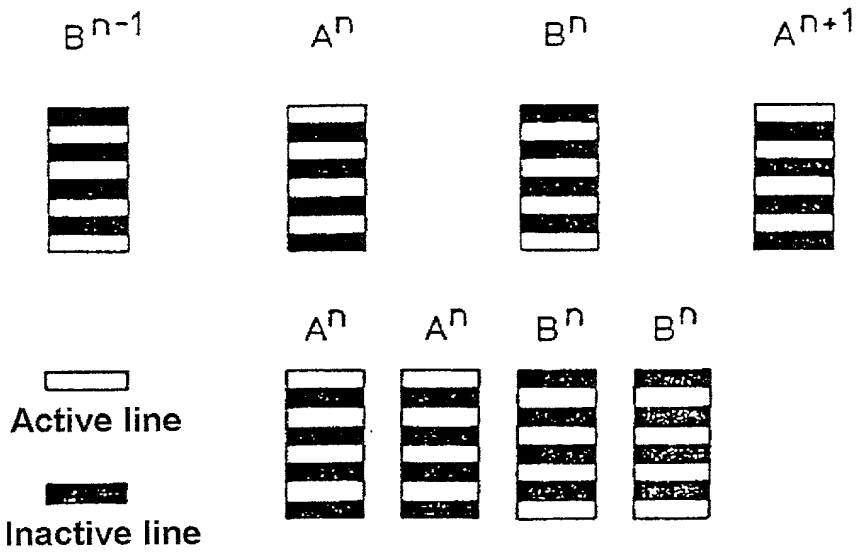


FIG 7b

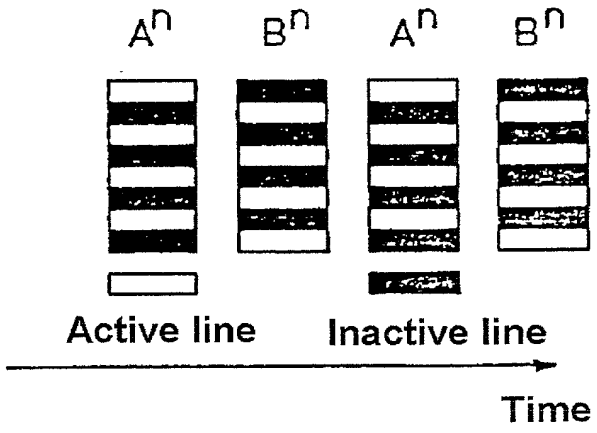


FIG 8

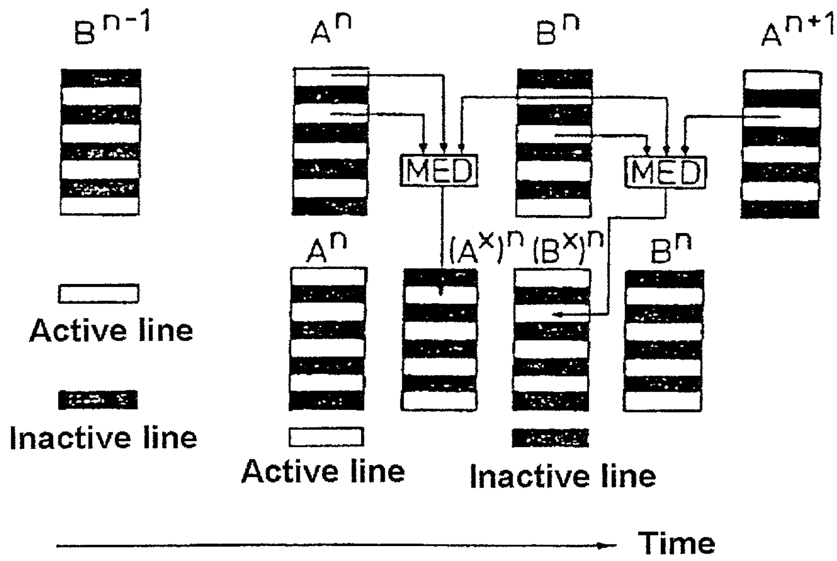
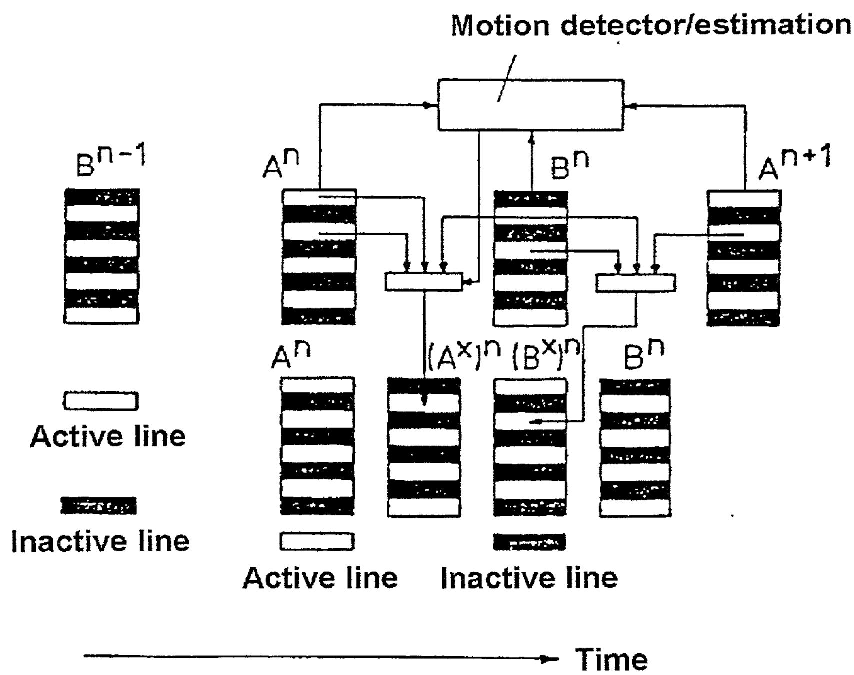


FIG 9



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Declaration and Power of Attorney for Patent Application
English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

CIRCUIT FOR FRAME RATE CONVERSION

the specification of which

(check one)

[ ] is attached hereto.
[X] claims priority of PCT/DE99/02938, filed September 15, 1999 and German Patent Application DE 198 44 937.2, filed September 30, 1998.

(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

(Number)	(Country)	(Day/Month/Year Filed)	Priority Not Claimed
DE 198 44 937.2	Germany	30 September 1998	[ ]
			[ ]
			[ ]

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

______________________	______________________
(Application Serial No.)	(Filing Date)
______________________	______________________
(Application Serial No.)	(Filing Date)
______________________	______________________
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. Section 120 of the United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark office all information known to me to be material to patentability as defined in Title 37, C.F.C., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

PCT/DE99/02938	September 15, 1999	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
______________________	______________________	______________________
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
______________________	______________________	______________________
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

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